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Conference Program And Book of Abstracts

Organised by

Wigner Research Center for Physics,

Institute for Solid State Physics and Optics

INFLUENCE OF MATERIAL DEGRADATION DUE TO PUNCHING ON MAGNETIZATION AND IRON LOSSES OF HIGH-STRENGTH NON-ORIENTED ELECTRICAL STEEL FOR TRACTION DRIVES

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Mechanical punching, cutting, etc. allows industrial processing of sheet material at low cost and therefore remains the most popular way to produce laminations for electrical machines and transformers. Laser cutting is an alternative mainly used for prototyping or small series (commonly assumed to have less negative effects on magnetic material properties). The deteriorating effect of the cutting process on the magnetic properties of the material close to the cut-edge is well known [1]. When the steel sheet experiences plastic deformation, mechanical energy supplied to the material is absorbed by the lattice through a crystallographic slip by means of dislocation motion. This results in a local modification of the microstructure (dislocations, internal stresses, grain morphology) influencing both the magnetic and mechanical properties of the steel [1, 2].

Improved estimation of iron losses occurring in stator and rotor core of machines is essential for the design of highly efficient electrical drives [3]. Therefore, the relationship between deterioration of magnetic, mechanical properties, alloy type [3], material thickness, rolling direction, and other parameters needs to be investigated and included in the design process of electrical machines.

The full-paper presents a quantitative analysis of the influence lamination processing for particularly high-strength non-oriented electrical steels over a wide range of frequencies to study the influence of increasing eddy-currents on the cut-edge-effect and to reproduce the operating range of electrical machines in the envisaged applications [4]. On that account, material characteristics are measured for samples with different ratios of cut-edge length vs. overall lamination volume, *i.e.*, varying the amount of cut-edge length related to the material volume. A number of single sheet tester samples of 120 mm x 120 mm are cut in smaller stripes by guillotine cutting (simulating the actual punching) others by laser cutting, resulting in different sample sets with additional guillotine/laser cut-edges (total width remains 120 mm). In order to study the impact on the magnetization behavior, quasi-static measurements with negligible amount of eddy-current disturbance are conducted. Based on measured data the impact on the different loss terms in the IEM-formula [4], is analyzed in detail. A differentiated understanding of the influences can be obtained, and thus the sensitivity of the various terms in terms of the processing of steel laminations be evaluated. This is important for the design of electrical machines, but also for the development of application-specific electrical steels.

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